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## PATENT SPECIFICATION

### 593,210



Application Date: June 20, 1945.

No. 15728/45.

Complete Specification Left: May 1, 1946.

Complete Specification Accepted: Oct. 10, 1947.

### PROVISIONAL SPECIFICATION

## Improvements in or relating to Screw and Nut Transmission Mechanism

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### ERRATA

SPECIFICATION No. 593,210.

10 a no  
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Page 1, line 17, for "describd" read  
"described"  
Page 1, line 54, for "prefered" read  
"preferred"  
Page 2, lines 11-12, for "maintaintd" read  
"maintained"  
Page 3, line 26, for "matric" read  
"matrix"

THE PATENT OFFICE,  
29th October, 1948.

20

formed by the flanks and crest of the  
intervening part of the screw grooving  
25 whereby the total change of direction of  
the balls being transferred from one end  
to the other of the helical turn is effected  
by successive small changes of direction  
of the port in different planes correspond-  
30 ing substantially with the shape of the  
intervening part of the screw grooving at  
small angles thereto.

The object of the present invention is  
to provide an improvement in or modi-  
35 fication of the invention forming the sub-  
ject of the said prior application designed  
to simplify the manufacture of the device  
to meet certain conditions encountered in  
practice and render screw and nut trans-  
40 mission mechanism applicable to a number  
of additional uses.

According to the present invention screw  
and nut transmission mechanism of the  
kind described is characterised in that the  
45 short transfer passage or port in the nut  
between substantially the ends of one  
helical turn or convolution therein is con-  
stituted or completed by an element  
adapted to be inserted through an aper-  
50 ture in the nut and provided with de-

to the adjacent groove of the  
ing crest of the screw thread. To achieve  
this end a slot is formed in the wall of 75  
the nut, the said slot being of substan-  
tially rectangular form with semi-circular  
ends and lying along an axis which is  
inclined to the axis of the nut. Into the  
slot thus formed is adapted to be inserted 80  
a unitary device hereinafter called "the  
transfer element" which is of substan-  
tially semi-circular internal cross section  
to receive the balls and is bent or arched  
in the direction of its length so that parts 85  
of its end portions will engage in two  
adjacent grooves of the screw-threaded  
spindle while its mid-portion, which is  
adapted to lie within the confines of the 90  
nut, permits the balls to pass one at a time  
successively in either direction, according  
to the hand of rotation of the screw or  
nut, over the crest of the said screw-thread  
between the two adjacent helical turns in  
which the deflecting ends of the said ele- 95  
ment engage. In order to position the said  
element accurately within its aperture and  
in relation to the screw-threads in the nut  
and on the spindle, locating means are  
formed or fixed within the slot and these 100

[Price

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## PROVISIONAL SPECIFICATION

## Improvements in or relating to Screw and Nut Transmission Mechanism

I, JOHN GEORGE DOUGLAS, a British Subject, of Dirgarve, Aberfeldy, Perthshire, Scotland, do hereby declare the nature of this invention to be as follows:—

This invention relates to screw and nut transmission mechanism of the kind wherein the driving connection between complementary helical grooving formed in a nut and on a screw is constituted by a number of balls interposed in said grooving whereby rotation of the one member relatively to the other results in relative axial movement with only rolling friction between the screw and nut members.

In a prior application No. 583,532 I have described an arrangement of the kind above referred to wherein the transfer of the balls between adjacent ends of one helical turn of the grooving is facilitated by a short transfer passage or port in the nut, one wall or side of said port being formed by the flanks and crest of the intervening part of the screw grooving whereby the total change of direction of the balls being transferred from one end to the other of the helical turn is effected by successive small changes of direction of the port in different planes corresponding substantially with the shape of the intervening part of the screw grooving at small angles thereto.

The object of the present invention is to provide an improvement in or modification of the invention forming the subject of the said prior application designed to simplify the manufacture of the device to meet certain conditions encountered in practice and render screw and nut transmission mechanism applicable to a number of additional uses.

According to the present invention screw and nut transmission mechanism of the kind described is characterised in that the short transfer passage or port in the nut between substantially the ends of one helical turn or convolution therein is constituted or completed by an element adapted to be inserted through an aperture in the nut and provided with de-

flectors for guiding the balls into and out of the said transfer passage or port.

In carrying the invention into effect and according to the preferred form thereof the improved screw and nut transmission mechanism comprises a screw threaded spindle which may, for example, form part of or be operated by the steering column of a vehicle and a nut mounted upon said screw threaded spindle and connected to the mechanism to be operated or controlled. The driving connection between the screw threaded spindle and the nut is constituted by a number of balls movably mounted in an unobstructed circulating path or endless circuit embracing substantially one helical turn. This endless path or circuit is formed by deflector members which extend into adjacent helical grooves of the screw-thread and by a transfer passage or port which enables the balls to pass from one groove to the adjacent groove over the intervening crest of the screw thread. To achieve this end a slot is formed in the wall of the nut, the said slot being of substantially rectangular form with semi-circular ends and lying along an axis which is inclined to the axis of the nut. Into the slot thus formed is adapted to be inserted a unitary device hereinafter called "the transfer element" which is of substantially semi-circular internal cross section to receive the balls and is bent or arched in the direction of its length so that parts of its end portions will engage in two adjacent grooves of the screw-threaded spindle while its mid-portion, which is adapted to lie within the confines of the nut, permits the balls to pass one at a time successively in either direction, according to the hand of rotation of the screw or nut, over the crest of the said screw-thread between the two adjacent helical turns in which the deflecting ends of the said element engage. In order to position the said element accurately within its aperture and in relation to the screw-threads in the nut and on the spindle, locating means are formed or fixed within the slot and these

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locating means may comprise two oppositely disposed lugs projecting inwards from the sides of the slot and adapted to engage corresponding recesses formed in the sides of the transfer element.

During the operation of the transmission mechanism the said transfer port is usually totally enclosed by an external housing and the transfer element is thereby held down in engagement with the said locating lugs so that it is positively maintained in its operative position to provide a clear and unobstructed path for the transfer of the balls from one helical turn to the other. Alternatively, the transfer element can be retained in operative position by screws, rivets or any other locking or latching devices.

Parts of the ends of the said transfer element by projecting into adjacent helical turns of the screw thread form deflecting elements having faces which lie substantially parallel the one to the other but which are inclined to the axis of the nut. These faces form part of the side walls of the transfer element and are shaped so that the transfer of the balls out of or into the load-carrying helix is facilitated as much as possible and sharp deflections eliminated.

The means above described for locating the transfer element within the slot may vary considerably in accordance with the particular type of transmission mechanism to which the invention is to be applied, and the said locating means may comprise projections formed on the sides or ends of the transfer element and adapted to engage freely in or be fixed into recesses formed in the adjacent walls of the nut.

According to a modified form of the invention the said transfer element instead of having internally the form of a semi-circular or U-shaped channel, may be internally of tubular form with open ends, its general internally arched shape and arrangement being similar to that already described. The use of such an element provides a transfer path in passing through which the balls leave one helical turn of the screw thread and are transferred to the adjacent helical turn without touching the intermediate crest of the screw thread. Parts of the ends of the transfer element are shaped as before to form deflector faces which project into the screw grooving and the internal form of the transfer element is such that in co-operation with the deflector faces, a transfer passage is provided substantially free from sharp deflections so that an unobstructed circulating path is provided for the balls.

Either arrangement above described may be multiplied by forming two or more independent ball circuits within the confines of one nut, each such circuit being completed by the insertion of one of the said transfer elements.

In either arrangement above described deflector elements or blocks as described in Application No. 583,582 may be employed in conjunction with the said transfer elements.

Dated this 20th day of June, 1945.

HERON ROGERS & CO.,

Agents for Applicant,

Bridge House,

181, Queen Victoria Street,  
London, E.C.4.

## COMPLETE SPECIFICATION

### Improvements in or relating to Screw and Nut Transmission Mechanism

I, JOHN GEORGE DOUGLAS, a British Subject, of Dirgarva, Abertfeldy, Perthshire, Scotland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to screw and nut transmission mechanism of the kind described in my prior Patent No. 490,938 wherein the driving connection between complementary helical grooving formed in a nut and on a screw is constituted by a number of balls interposed in said grooving whereby rotation of the one member relatively to the others results in relative

axial movement with only rolling friction between the screw and nut members.

In a prior Patent Specification No. 583,582, I have described an arrangement of the kind above referred to wherein the transfer of the balls between adjacent ends of one helical turn of the grooving is facilitated by a short transfer passage or port in the nut, one wall or side of said port being formed by the flanks and crest of the intervening part of the screw grooving whereby the total change of direction of the balls being transferred from one end to the other of the helical turn is effected by successive small changes of direction

of the port in different planes corresponding substantially with the shape of the intervening part of the screw grooving at small angles thereto.

- 5 The object of the present invention is to provide an improvement in or modification of the invention forming the subject of the said prior Patent No. 490,938 designed to simplify the manufacture of the device to meet certain conditions encountered in practice and render screw and nut transmission mechanism applicable to a number of additional uses.

- 10 According to the present invention screw and nut transmission mechanism of the kind described is characterised in that a transfer passage or port between substantially the ends of one helical turn or convolution is formed by an elongated slot 20 in the nut extending between adjacent helical grooves of the nut thread and a liner of channel section inserted in said slot, the ends of said liner being formed to close the ends of the helical convolution in the nut within which the balls are 25 situated and to deflect the balls through a clear and unobstructed path from the one end of the convolution to the other.

- Reference will now be made to the 30 accompanying drawings which show a construction according to the invention and in which:—

Fig. 1 is a plan of part of a screw and nut transmission unit,

- 35 Fig. 2 is a fragmentary section taken on the line II—II of Fig. 1, to an enlarged scale,

Fig. 3 is a sectional view taken on the line III—III of Fig. 2,

- 40 Fig. 4 is an elevation of the transfer element or liner shown in Figs. 2 and 3, and

Fig. 5 is an inverted plan of the liner shown in Fig. 4.

- 45 In the construction illustrated, the improved screw and nut transmission mechanism comprises a screw threaded spindle *a* which may, for example, form part of or be operated by the steering column of a vehicle, and a nut *b* mounted upon said 50 screw threaded spindle and connected to the mechanism to be operated or controlled. The driving connection between the screw threaded spindle and the nut is constituted by a number of balls *c* movably mounted in an unobstructed circulating path or endless circuit in the nut embracing substantially one helical turn. The said endless path or circuit is formed 60 by deflector members which may extend into adjacent helical grooves of the screw-thread or slightly inside the pitch circle of the balls therein and by a transfer passage or port which enables the balls to 65 pass from one groove to the adjacent

groove over and in contact with the intervening crest of the screw thread. To achieve this end a slot *d* formed in the wall of the nut, the said slot being of substantially rectangular form with semi-circular ends as shown in Fig. 1 and lying along an axis which is inclined to the axis of the nut. Into the slot *d* is adapted to be inserted a unitary device constituting a transfer element or liner *e* which is of substantially semi-circular or U-shaped internal cross section as shown in Fig. 3 to receive the balls *c* and is bent or arched at *m* in the direction of its length as shown in Fig. 2, between its end portions *f* and *g*. The mid-portion *n* of the liner, which is adapted to lie within the confines of the nut, permits the balls *c* to pass successively in either direction, according to the hand of rotation of the screw or nut, over the crest *k* of the screw-thread *a* and around one helical turn within the limits imposed by the deflecting ends of the liner *e*.

In order to position the liner *e* it is soldered in place in the slot *d*, parts of the solder matrix being indicated at *l* in Figs. 2 and 3. The solder preferably completely fills those parts of the slot *d* which are not occupied by the liner *e* and the outer part of the solder matrix may be finished off coincident with the outer surface of the nut. The arch or hump *m* (Figs. 2 and 3) of the liner *e* may be either coincident with the outer surface of the nut, or lie below that surface with gap filled by the solder matrix. The wall thickness of the nut can thus be a factor independent of the ball diameter or the thickness of the liner wall. Instead of employing solder, any other convenient method of securing the liner *e* in operative position may be employed. For example, two oppositely disposed lugs may be arranged to project inwards from the sides of the slot *d* adapted to engage corresponding recesses in the liner, this arrangement being particularly suitable where the nut is totally enclosed by an external housing which positively maintains the liner in its operative position. Alternatively, the liner can be retained in operative position by screws, rivets, or other locking or latching devices.

The ends of the liner *e* are shaped to form deflecting and guiding elements *n*, *o*, *p* and *q* (Figs. 2 and 5). The elements *o* and *p* are curved inwardly of the liner and chamfered or bevelled on their inner surfaces so as to eliminate sharp deflections and provide a smooth, unobstructed open path for the transfer of the balls out of or into the load carrying helix. The elements *n* and *q* are arranged to project across the otherwise open ends of the helical groove of the nut which are exposed

by the slot  $d$ , and serve to maintain a closed circuit for the balls. The path of ball movement through the liner  $e$  is shown by the broken line positions of the balls in Fig. 1 wherein the approximate positions of the deflecting elements  $n$ ,  $o$ ,  $p$  and  $q$  are also shown. The internal width of the liner and the distance of its arch  $m$  radially from the screw groove and crest are such that the balls  $c$  can pass freely, but without excessive looseness, through the channel formed by the liner  $e$  during transference from one end to the other of the working helix in either direction or hand of rotation, and so that the balls during such transference are entirely free from any load either radial or axial, such loads being taken entirely by the balls in the working helix. The initial or leaving contact point in the liner channel and on element  $n$  or  $q$  of the balls  $c$  is at  $A$  (Fig. 2) which coincides substantially with the pitch circle of the balls in the working helix, successive positions during transfer being indicated at  $A^1$ ,  $A^2$ ,  $A^3$  and  $A^4$ . The screw crest diameter  $B$  is always smaller than the pitch circle of the balls so that if the inner radius  $r$  of the side walls of the liner  $e$  and the deflector ends  $n$ ,  $o$ ,  $p$ ,  $q$  thereof just clear the crest by a running clearance, correct pick up and deflection of the balls is satisfied, and elements  $n$ ,  $q$  need not enter the screw-groove.

The arrangement above described may be multiplied by forming two or more independent ball circuits within the confines of one nut, each such circuit being completed by the insertion of a liner  $e$  as above described.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Screw and nut transmission mechanism of the kind described characterised

in that a transfer passage or port between substantially the ends of one helical turn or convolution is formed by an elongated slot in the nut extending between adjacent helical grooves of the nut thread and a liner of channel section inserted in said slot, the ends of said liner being formed to close the ends of the helical convolution in the nut within which the balls are situated and to deflect the balls through a clear and unobstructed path from the one end of the convolution to the other.

2. Screw and nut transmission mechanism according to Claim 1 including a liner of channel section adapted to be fixed within a slot in the nut, the said liner being arched or humped in the direction of its length to permit the balls to pass successively in either direction over the crest of the screw thread.

3. Screw and nut transmission mechanism according to Claim 2 wherein the said liner is formed at two diagonally opposed corners to constitute baffles and deflectors to close the ends of the convolution in the nut within which the balls are situated and cut away and chamfered at the other two corners to form associated surfaces whereby the balls are guided into the liner-channel and from one end of the helical groove to the other.

4. Screw and nut transmission mechanism according to Claim 3 wherein the said liner is shaped to lie within the confines of the nut-wall and is secured in position by means of a solder matrix.

5. Screw and nut transmission mechanism constructed, arranged, and adapted to operate as herein described with reference to the accompanying drawings.

Dated this 1st day of May, 1946.  
HERON ROGERS & CO.,  
Agents for the Applicant,  
Bridge House,  
181, Queen Victoria Street,  
London, E.C.4.

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593,210 COMPLETE SPECIFICATION

1 SHEET

[This Drawing is a reproduction of the Original on a reduced scale.]

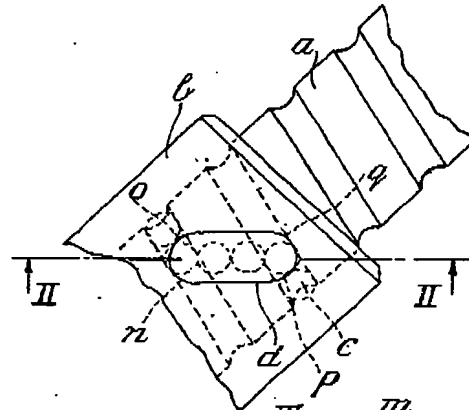


Fig. 1

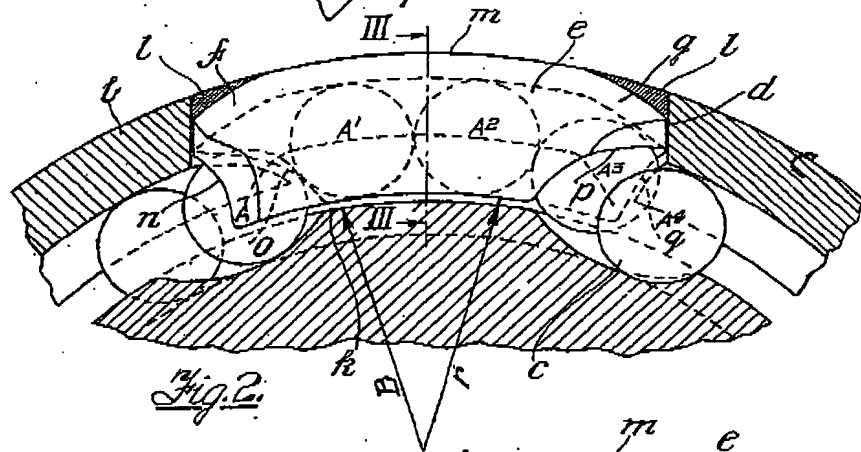


Fig. 2

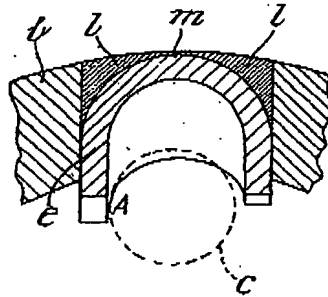


Fig. 3

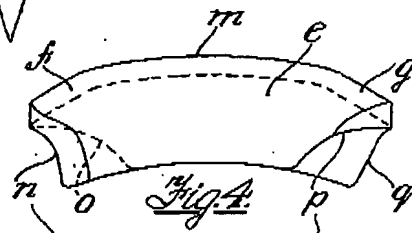


Fig. 4

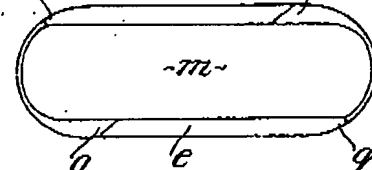


Fig. 5

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